RESEARCH HIGHLIGHTS

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LEBRETON FLATS DISTRICT HEATING SYSTEM PERFORMANCE ASSESSMENT

Introduction

The LeBreton Flats District Heating System (DHS) was commissioned in 1982 as part of a Federal-Provincial Government initiative to demonstrate the energy savings potential of low-temperature district heating systems. The system, located on the LeBreton Flats, one km from downtown Ottawa, provides hot water for space heating and domestic hot water for 142 neighbouring apartments and townhouses.

The LeBreton Flats DHS has now been operating for 20 years and Canada Mortgage and Housing Corporation (CMHC), the owner of the system, commissioned a study to review the energy use, operating costs, service history, general condition and client satisfaction with the system. The information generated by the study provides useful feedback concerning the cost-effectiveness of the system and how the system may be improved.

Research Program

The research program comprised six tasks:

- Informal interviews with customers of the LeBreton Flats DHS and the maintenance contractor to gain an overview of the heating system operation
- A review of utility and maintenance costs
- A comprehensive, non-destructive boiler inspection
- An evaluation of heating system performance
- A review of four alternative heating options for the buildings served by the DHS.

Research Results

The LeBreton Flats DHS was constructed in 1981 at a cost of $1,300,000 ($6,340 per unit), inclusive of the primary, secondary and ensuite systems. Originally, the DHS serviced 205 units. However, in 1990, 63 townhouses were disconnected from the system leaving 142 units. The DHS consists of a boiler plant and a hot water distribution system. The plant building is a sub-grade structure containing two 1,250 kW gas-fired fire tube boilers and pumping equipment. The heating system provides low-temperature hot water (80 to 90°C) for space and domestic hot water heating for the 142 units situated in three neighbouring apartment buildings and a series of townhouses, representing an estimated load of 800 kW.

Although the boilers are estimated to have a full load efficiency of 80 per cent, the boilers are oversized for the load thus a 70 per cent seasonal boiler efficiency is more likely. Ground heat losses were estimated to be 8 per cent of the annual boiler energy consumption.

Hot water is delivered to the client buildings via 75mm to 100mm pre-insulated pipe buried within the frost zone. Secondary distribution systems exist in each building to transfer the heat delivered by the primary system to either central or ensuite space and domestic hot water heating equipment.

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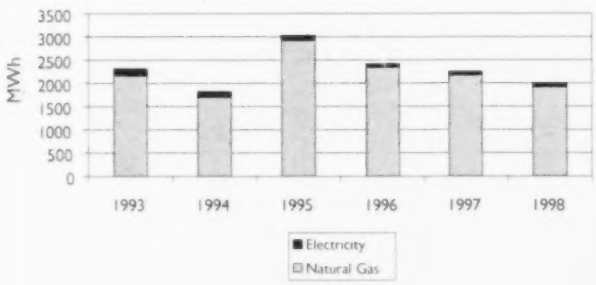
Energy Consumption and Costs

Utility invoices and DHS financial records were reviewed to assess the historical natural gas, electricity and water consumption and costs. Figure 1 depicts the natural gas and electricity use over several recent years.

Figure 1: Total DHS Annual Energy Consumption



The total energy costs per unit is modest. For example, in 1998, the annual energy costs were $255 per unit, the annual plant maintenance costs were $113 per unit for a total annual cost of $368 per unit. Electricity charges amount to 16 per cent of the energy cost. The circulation pumps and boiler fans are the primary consumers of electricity. The total annual operating costs for the DHS are shown in Figure 2 from the date the system was commissioned (other than 1995).

The disconnection of the 63 units in 1990 is apparent through the changes in natural gas consumption. Overall DHS operating costs did not decrease substantially in the following years due to an increase in maintenance costs. Non-energy costs such as taxes, insurance, administration and maintenance account for 30 to 40 per cent of the total annual operating costs.

The thermal energy delivered to the district heating piping network during 1998 was 1246 MWh, an average of 8.5 MWh per unit per year at a delivered cost of $43/MWh. These figures include the cost of maintenance. These costs compare favorably with CMHC studies of energy use in apartment buildings with conventional space and domestic hot water heating equipment.

Boiler Inspection

The system continues to operate with its original boilers, which have been retubed on two occasions. A thorough, non-destructive inspection of both boilers found retubing was again necessary due to pitting of the water side of the tubes. The pitting was likely caused by the inadequate control of water chemistry.

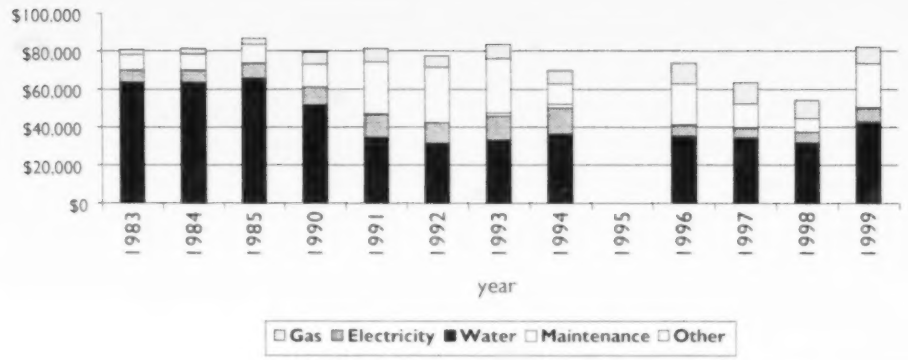
System Monitoring

The heating distribution system was inspected and monitored during August and November of 1999. Much of the monitoring compared the supply and return water temperatures and flows in the primary hot water distribution loop. Several opportunities to optimize the performance of the system were discovered such as reducing summertime flows, better control of hot water flow in apartment and townhouse fan-coils during the heating season and the use of variable speed drives on the circulation pumps.

Interviews with DHS Clients

Residents are satisfied with the heating system and they report being comfortable and having sufficient hot water although there were complaints about the variability of water temperature. The lack of an accurate metering system to account for energy use by each of the DHS clients was also a concern.

Figure 2: Annual Plant Operating Costs



Evaluation of Other Heating Options:

Four alternative heating options for the clients of the LeBreton Flats DHS were examined to assess the competitiveness of the DHS given other available heating systems:

1. retubing and upgrading the existing boilers
2. decommissioning the DHS, installing individual heating systems in all units
3. installing two 500 kW boilers to better meet load conditions
4. installing a combined heat and power system

The Net Present Cost (NPC) of initial and future expenditures, including equipment, installation, all gas and electricity expenditures, taxes, insurance, maintenance, administration and interest for each scenario was determined. The Net Present Value (NPV) of all revenue from energy sales less the NPC was also calculated. Table 1 indicates the NPV and NPC for each of the four heating options examined.

The most economical option for the LeBreton Flats District Heating System was determined to be scenario 3, the replacement of one of the boilers with two smaller units. This would allow the capacity of the heating plant to be trimmed to meet partial load conditions thereby improving system efficiency.

External Sources Of Waste Heat

It is possible that waste heat from a nearby source (a paper mill or a government combined heat and power plant) could be utilized as a heat source in the future. Energy purchased from such a source would cost $20-30/MWh. The cost of connecting the LeBreton Flats DHS to either source was estimated to be $8-10/MWh. Thus the total cost of delivered energy would be less than $40/MWh making it a viable option.

Table 1: Economic Comparison of DHS System Options

25 Year Monetary Comparison of Four Heating Options		
Option	Net Present Value	Net Present Cost
1. Boiler upgrading	$ 123,000	$ 908,000
2. Individual furnaces and boilers	$ -25,000	$ 1,059,000
3. 2-500 kW boilers	$ 243,000	$ 847,000
4. Combined heat and power	$ 116,000	$ 592,000

Conclusions

The LeBreton Flats DHS, after 20 years of operation, continues to offer reliable and economic service to its clients. However, the performance of the system could be optimized through the adjustment of boiler cycling time, the use of variable speed drives, better control of hot water flow on the primary and secondary distribution system and the use of smaller boilers to meet partial load conditions.

Increasing the client base and exploring options to make use of waste heat from a neighboring facility should be explored. Cogeneration may also be an option for the facility given the deregulation of the electricity generation industry in Ontario.

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Research Report: *A Performance Assessment of the Lebreton Flats District Heating System*, prepared for CMHC by Natural Resources Canada, February 2001.

Housing Research at CMHC

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